

He had travelled extensively in remote parts of Germany, had discovered many more plants than had been made known since the revival of botanical study in Germany, and had described these carefully in a work, "Historia Plantarum," left in manuscript. This was published some years after his death, edited by Conrad Gasner, who, by desire of the publisher, employed illustrations (prepared to accompany Tragus's work) to illustrate the descriptions of Cordus, to which they were occasionally incorrectly fitted. From a careful study of the descriptions, Dr. Greene shows cause to regard Valerius Cordus as of rare ability and insight, and esteems him to have been immeasurably the greatest of the "German fathers of botany." Among the services to botany ascribed to him we are told that "he is the inventor of the art of phyto-graphy"; that in all descriptions "attention is given to the morphology and life-history of the plant in as far as is known to him"; that new terms are employed expressing new ideas and points of view in the science, and that new conceptions appear in regard to inflorescences, flowers, fruits, and seeds. In taxonomy he shows clearer views with regard to species, and his groups were more often based on relationships than were those of his predecessors. A number of his groups of generic rank stand good, though in most cases the names given by him were needlessly changed by Linnæus. He paid heed to internal structure (so far as that could be determined by him, that is, by the unaided eye), and to physiology, as regards prefloration, modes of climbing, and similar features of plant-life. He also gave attention to the varieties of cultivated fruits, of which excellent descriptions are extant by him. What he succeeded in doing suffices to show how grievous a loss botany sustained in his early death.

VECTOR ANALYSIS.

Éléments de Calcul vectoriel, avec de nombreuses Applications à la Géométrie, à la Mécanique, et à la Physique mathématique. By Prof. C. Burali-Forti and Prof. R. Marcolongo. Édition française traduite de l'Italien et augmentée d'un Supplément par S. Lattès. Pp. vi+229. (Paris: A. Hermann et Fils, 1910.) Price 8 francs.

THE variety of matter contained in this small book shows the condensing power of vector notation, especially when combined with a concise literary style. The theoretical part includes the elements of the barycentric calculus, as well as a vector analysis in which vectors are written either in single letters, or in the form B-A, where A, B are points. Scalar and vector products are treated separately, so that quaternions do not come in. Special points to notice are that a scalar product has given to it the sign opposite to that assigned by Hamilton; the effect of this is that if α, β, γ are three orthogonal unit-vectors, $\alpha^2 = \beta^2 = \gamma^2 = 1$, and versors have to be treated by introducing a symbol i , such that $i^2 = -1$, and is not a vector. There is a good deal to be said for this; but it is most unfortunate that the authors take the clockwise sense of rotation for the positive one, especially

considering the use of vectors and vector products in physics.

The applications include geometrical, mechanical, hydrodynamical and electrical formulæ. Specially to be noted are the proofs of Green's theorem and its congeners, Stokes's theorem of circulation, and Hertz's formula for variation of flux.

There is an appendix, partly historical, partly critical and even polemic. Probably every reader will find something here with which he cordially disagrees; but there is one statement that deserves special attention. We believe that the authors are right in thinking that the final notation of the vector calculus will be based on Grassmann's "Ausdehnungslehre," as improved and modified by subsequent writers. The Hamiltonians will have nothing more than a sentimental grievance if this proves to be the case. Nothing can upset, or even modify, the quaternion calculus, because it is a definite type of linear algebra; the main question now is whether *this* algebra is the best for the treatment of physical, and especially electrical, problems. Judging by the attitude of Gibbs, Heaviside, and Lorenz (to name only these), the answer appears to be no.

There is very little fear that a really convenient notation will not be ultimately agreed upon; it will probably be invented by a physicist. Meanwhile, dispassionate observers will derive some amusement, as well as much instruction, from the lively controversies of the champions of this or that particular symbol, as if its retention or rejection were of vital importance in itself. For instance, our authors seriously object to a symbol such as $[a\beta]$ for a scalar product, on the ground that functional symbols are invariably placed on one side of the operand! The example of $\int y dx$, where $\int() dx$ is practically a functional symbol, shows that the statement is barely true, except in an artificial sense; but even if it were strictly true, this would be no reason for regarding it as a necessary law of mathematical notation.

G. B. M.

MAP-MAKING.

The Theory of Map-Projections, with special reference to the Projections used in the Survey Department. By J. I. Craig. Pp. iv+80. (Cairo: National Printing Department, 1910; Ministry of Finance, Egypt Survey Department.) Price 200 millimes.

THE subject of map projections is one in which the English language is strangely deficient, a deficiency the more apparent when contrasted with the wealth of Continental literature on the subject. Those interested in the higher theory of map-making will, therefore, welcome the appearance of this little treatise, which seems to give in a compact and practical shape all the essentials of this attractive branch of the geometry of surfaces. Starting with a statement of the problem to be solved, and an allusion to possible improvements in nomenclature; the term projection itself, in the meaning of a representation in accordance with any law, for instance, is not a particularly happy one; a history is given of the adop-

tion of the Gauss conformal meridional projection for the maps of the survey of Egypt. A general discussion of the figure of the earth, and the geometry of the surface of a spheroid, is then entered upon, leading the way to the theory of the representation of such a surface on a plane sheet and the involved balancing of errors. These general results are then applied to the standard projections, so that, while special attention is devoted to the Egyptian mapping, the major part of the book is of quite general application. The methods of investigation are, in many cases, new, and the mathematical forms concise and elegant.

As an interesting example of specialisation, we may note the investigation, on p. 61, of the Mecca retro-azimuthal projection, which would provide a map giving the true bearing of Mecca at any point.

The great variety of projections used for the maps of different countries gives rise to certain inconveniences, and it is an arguable point whether it would not be possible and desirable to reduce this number to a few standard forms by international agreement. What has already been accomplished in the case of the 1/1,000,000 map of the world might be extended to apply to other scales. We commend the subject to the attention of the next International Geographical Conference. It must always be borne in mind that while the selection of a suitable projection is important for atlas or general maps upon small scales, it is comparatively unimportant for large-scale survey maps produced in sheets, so long as each sheet is projected separately. The errors due to defects in the projection are always small compared with those due to the distortion of the paper upon which the map is drawn or printed.

E. H. H.

OVERHEAD AND UNDERGROUND ELECTRIC LINES.

Lignes Électriques Souterraines. Études, pose, essais, et recherches de défauts. Pp. 207.

Lignes Électriques Aériennes et Souterraines. Études, pose et essais. Pp. 181. By C. Giradet and W. Dubi. (Grenoble: J. Rey; Paris: Gauthier-Villars, 1910.) Price 5 francs each.

THE superscription on each of these volumes: "Bibliothèque de l'élève-ingénieur," seems to indicate that they are written by and for graduates of engineering colleges, and this impression is confirmed by an introduction contributed by Prof. J. Pionchon, of the Dijon University, in which we are told that the "library" is intended to form a kind of post-graduate instruction to engineering students. To expect students shortly after they have graduated to be able to become authors on technical subjects and write books, which shall be good enough to serve as further instruction to other students which may graduate a year or two later, is hardly reasonable; but in the present case the difficulty is partly overcome by the circumstance that one of the authors is not a student fresh from college, but evidently a man of considerable practical experience in overhead power lines and cable work.

Yet the result of the collaboration is rather disappointing.

The books are neither scientific—in the sense of showing the connection between engineering practice and scientific principles—nor are they very practical in the sense of containing definite instructions. There is a little of each, and a good deal of what may be described as general talk on the subject, and containing little which is not self-evident to a man of average intelligence. Thus, when the authors tell us that overhead power-lines should be so constructed that copper may be added as the demand for power increases, everybody will agree, but is it necessary to labour so obvious a matter? On the other hand, some of the general talk is misleading. Take the statement that cables for very high pressure have no practical importance, since cables are only used within towns, that is, over relatively short distances; or the recommendation to earth the middle wire in a three-wire system at every junction box. Then, again, we find ten pages of what may be called general talk about various junction boxes, but not a single drawing to illustrate the types discussed; whilst the important matter of mechanical protection of cables is dealt with on only two pages, and illustrated by two small scale sections, one showing bricks laid over the cable longways and the other showing them broadways.

The most elaborate technical part of the book on underground lines is that on localisation of faults, and here, by the preface, we are led to expect specially valuable information; for the authors say in it that although the methods given in "some text-books" are sufficiently well known, yet their practical application under the varying and difficult condition of actual service, demand special elaboration. This is certainly true, and one turns with eager expectation to the chapter in question in order to see what the authors have to say about these special devices. Here again we are rather disappointed; although the author who has contributed this part is certainly a man who knows his subject well, and gives a series of practical and numerical examples evidently culled from his practice, one does not find much which may be considered as new methods. Our old friend the loop test crops up in various guises, and when we are told that a special wire must be run where no sound cable is available to complete the loop, the advice is, no doubt, quite serviceable, but it can hardly be considered as an advance upon the text-book method; it is simply an obvious way of carrying it out.

For the localisation of a break in the conductor a method based upon measurement of capacity is recommended. This also is old. Most engineers will expect that when a cable parts bodily the insulation at the break will also be destroyed, so that a method based on the measurement of capacity becomes inapplicable; but, curiously enough, the authors give a case from their experience where the insulation had remained perfect. The history of this breakdown, and of the expedients employed to keep the service up under a variety of great difficulties, is very interesting reading, whilst the fact that the engineers were able to locate the break within a few yards is a striking vindication of a method which at first sight seems of doubtful value. What the authors have to say about the legal